



### **Alternative Attitude Commanding and Control for Precise Spacecraft Landing**

A report proposes an alternative method of control for precision landing on a remote planet. In the traditional method, the attitude of a spacecraft is required to track a commanded translational acceleration vector, which is generated at each time step by solving a two-point boundary value problem. No requirement of continuity is imposed on the acceleration. The translational acceleration does not necessarily vary smoothly. Tracking of a non-smooth acceleration causes the vehicle attitude to exhibit undesirable transients and poor pointing stability behavior. In the alternative method, the two-point boundary value problem is not solved at each time step. A smooth reference position profile is computed. The profile is recomputed only when the control errors get sufficiently large. The nominal attitude is still required to track the smooth reference acceleration command. A steering logic is proposed that controls the position and velocity errors about the reference profile by perturbing the attitude slightly about the nominal attitude. The overall pointing behavior is therefore smooth, greatly reducing the degree of pointing instability.

*This work was done by Gurkirpal Singh of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).  
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### **Inspecting Friction Stir Welding Using Electromagnetic Probes**

A report describes the use of advanced electromagnetic probes to measure the dimensions, the spatial distribution of electrical conductivity, and related other properties of friction stir welds (FSWs) between parts made of the same or different aluminum alloy(s). The probes are of the type described in "Advanced Electromagnetic Probes for Characterizing Materials" (GSC-13878), *NASA Tech Briefs*, Vol. 21, No. 11 (November 1997), page 4a. To recapitulate: A probe of this type is essentially an eddy-current probe that includes a primary (driver) winding that meanders and multiple secondary (sensing) windings that meander along the primary winding. Electrical conductivity is commonly used as a measure of heat treatment and tempering of aluminum alloys, but prior to the development of these probes, the inadequate sensitivity and limited accuracy of electrical-conductivity probes precluded such use on FSWs between different aluminum alloys, and the resolution of those probes was inadequate for measurement of FSW dimensions with positions and metallurgical properties. In contrast, the present probes afford adequate accuracy and spatial resolution for the purposes of measuring the dimensions of FSW welds and correlating spatially varying electrical conductivities with metallurgical properties, including surface defects.

*This work was done by David G. Kinchen of Lockheed Martin Corp. for Marshall Space Flight Center. For further information contact Gary Willett at (504) 257-4786.*

*Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 USC 2457 (f)] to Lockheed Martin Space Systems Company — Michoud Operations. Inquiries concerning licenses for its commercial development should be addressed to:*

*Lockheed Martin Michoud Space Systems  
P.O. Box 29304  
New Orleans, LA 70189.*

*Refer to MFS-31979, volume and number of this NASA Tech Briefs issue, and the page number.*

### **Helicity in Supercritical O<sub>2</sub>/H<sub>2</sub> and C<sub>7</sub>H<sub>16</sub>/N<sub>2</sub> Mixing Layers**

This report describes a study of databases produced by direct numerical simulation of mixing layers developing between opposing flows of two fluids under supercritical conditions, the purpose of the study being to elucidate chemical-species-specific aspects of turbulence, with emphasis on helicity. The simulations were performed for two different fluid pairs — O<sub>2</sub>/H<sub>2</sub> and C<sub>7</sub>H<sub>16</sub>/N<sub>2</sub> — at similar values of reduced pressure.

*This work was done by Nora Okong'o and Josette Bellan of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).  
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